



eur PLANET 2024

Research Infrastructure

H2020-INFRAIA-2019-1

Europlanet 2024 RI has received funding from the European Union's Horizon 2020 Research and Innovation Programme under

Grant agreement no: 871149

Deliverable D7.9

Deliverable Title: VESPA JRA 4th Year Report
Due date of deliverable: 31st January 2024
Nature¹: Report
Dissemination level²: Public
Work package: WP7
Lead beneficiary: OBSPARIS
Contributing beneficiaries:
Document status: Final

Start date of project: 01 February 2020
Project Duration: 54 months
Co-ordinator: Prof Nigel Mason, University of Kent

1. **Nature:** R = Report, P = Prototype, D = Demonstrator, O = Other

2. **Dissemination level:**

PU	PP	RE	CO
Public	Restricted to other programme participants (including the Commission Service)	Restricted to a group specified by the consortium (including the Commission Services)	Confidential, only for members of the consortium (excluding the Commission Services)

Executive Summary / Abstract:

A progress report for year 4 of the Virtual European Solar and Planetary Access (VESPA) Joint Research Activity of the Europlanet 2024 Research Infrastructure is provided.

The VESPA infrastructure has been upgraded and made compliant with recent standards.

The main portal has been redesigned and modernized to improve the user experience and support the expected increase in number of data services. Alternative query interfaces have also been designed, in particular to support georeferenced data. The study of the usability of EOSC in the context of VESPA was also continued.

Table of Contents

1. Explanation of VESPA WP7/JRA2 Work & Overview of Progress	4
a) Objectives	4
b) Explanation of the work carried in WP	4
c) Impact to date	7
d) Follow-up activity / sustainability	8
2. Update of data management plan	8
3. Follow-up of recommendations & comments from previous review(s)	8

1. Explanation of VESPA WP7/JRA2 Work & Overview of Progress

a) Objectives

Task 1.

- Coordination – ObsParis, CBK-PAN + JacobsUni

Task 2.

- Infrastructure – ObsParis, CNRS/IRAP + UCL, CBK-PAN, CNRS/CDS
- Setting the stage for use of EOSC in VESPA (for services and computation); Implementing the code-on-line platform OPUS to analyse data.

Task 3.

- Tools & Interfaces – JacobsUni, CNRS/CDS + Heidelberg, Spacefrog, Bristol Uni, ObsParis, CNRS/IRAP
- Improving user interfaces, visualisation / analysis tools, and data servers

Task 4.

- Design of internal services – CNRS/IPSL, CNRS/IRAP + ObsParis, JacobsUni, DLR
- Studies of services requiring specific design, such as Global Climate Models, VO-GIS interfaces, etc

b) Explanation of the work carried in WP

The present report is one of the deliverables of WP7 VESPA VA (D7.9). The other deliverable due in year 4 is:

#	Title	Delivery date (internal)
D7.8	New version of main portal with improved user interface + User experience audit report	25/7/2023

The schematic VESPA infrastructure is summarised in Fig. 1 to help follow this discussion.

Acronyms are explained here: <http://www.europlanet-vespa.eu/glossaire.shtml>

Tools of interests are listed here: <http://www.europlanet-vespa.eu/tools.shtml>

Task 1

Task 1 is responsible for the overall coordination and management of the JRA. Interaction tools to support the VESPA JRA team have been installed at the start of the project. Deliverables and milestones are listed and linked from this page:

<https://voparis-wiki.obspm.fr/display/VES/Deliverables+and+milestones%2C+EPN2024>

The VESPA Confluence site also contains extensive material about the WP activity.

Coordination of the two VESPA WPs has again focused on discussions in smaller groups during year 4. Small group interactions are particularly efficient for the JRA / WP7, as the activity mostly involves detailed technical developments.

Task 2

- The VESPA infrastructure has been upgraded following the validation of the EPN-TAP data access protocol as an international standard in August 2022. Most data servers located in beneficiary institutes have been upgraded to benefit from new support functions; therefore, most data services are now compliant with the final standard (see VA report).

- The service registration process has been updated to be more in-line with (evolving) VO practices, again thanks to server updates. The central IVOA registry has also been cleaned up to remove early and deprecated assessments of EPN-TAP services (including from external teams). This has allowed us to propose complete access to EPN-TAP services from the command line, as an alternative to portal access (tutorials here: <https://github.com/ePN-vespa/tutorials/blob/master/misc/Jupyter-notebook-access>).
- Automated monitoring has been installed at ObsParis. It tests the status of EPN-TAP services from Europlanet 2024 RI beneficiaries regularly and sends messages to the maintenance teams if the services are down or removed from the IVOA registry (e. g., after updates). It also performs unit tests to check if the data files are still reachable (e. g. to address a side effect of the migration of the portal to the https domain).
- The DaCHS server (recommended to install new EPN-TAP services) has been updated to v2.7 to include specific support for EPN-TAP and the inclusion of vectors in the tables (MS96). The current version 2.9 released in December 2023 supports more flexible uses of datalink to associate derived data (a request from the VESPA team) and the latest versions of the community Python libraries (astropy and sunpy).
The DaCHS installation on Docker and EOSC (MS41 during year 2) has been fine-tuned and was validated during the VA implementation workshop in Graz (June 2023).
- The mirror of CDS planetary HiPS catalogue at ObsParis has been rebuilt according to new standards. HiPS are now accessed from the IVOA registry, as they should be.
- The OPUS job management platform developed in H2020 ESCAPE was installed for VESPA on a fixed machine at ObsParis during year 1. The deployment on a local cluster and on EOSC servers has been successfully achieved during year 3 (D7.6). Cluster configuration and management on EOSC (e.g., shutting off unused nodes to save power, or dynamically adding new nodes to face peak activity periods) have been implemented during year 4 with the help of EGI.
- The main VESPA query portal has been registered in the EOSC marketplace.

Task 3

Tools

- During the Europlanet 2020 RI programme, we developed a plugin for the open-source application ImageJ, to enlarge format support and add image processing functions in the VO. This plugin has been updated for the current version of ImageJ and now also works with the AstrolImageJ variation which is widely used by the amateur community – the new plugin was released in Oct 2023 on the VESPA GitHub (<https://github.com/ePN-vespa>).
- The APERICubes tool to display spectral cubes on-line has been transferred to https domain, and the doc updated.

Main VESPA portal

- User feedback collected during year 3 has been used to improve the user interface. A series of proposals were made by SpaceFrog on this basis (MS81), some of which have been implemented in successive updates (Sept 2022 and June 2023 releases, D7.8). Other proposals are being tested in the VA and will be published after validation. This includes:
 - Display in gallery view exposing thumbnails (alternative to the classical table output)
 - Restriction of queries to thematic groups of services.
- A preliminary version of the Observation Facility name resolver designed in the VA has been tested on the main portal.
- More technical aspects include the upgrade of frameworks and libraries in use (python3 / Django 4.2 / Bootstrap 5), and multithreading of global queries, which greatly improved the

responsivity of the main search interface. This will enable support for 100 to 200 data services in the near future.

- Improvements in the SSHADE user interface pertain to the VA WP.

'Discovery' portal

An ElasticSearch database was setup in year 2 to allow users to query services in “natural language” (Google-like). This requires frequent uploads of metadata from all existing services in a central place, which was initially a blocking point in particular because of the huge size of ESA’s Planetary Science Archive (30 million files). This difficulty has been overcome by discussing the implementation with ESA.

In addition, spatial coverages are now computed for all services and added to this central database – using the IVOA MOC standard, which is much more efficient than the contour system initially used in EPN-TAP (see task 4 below).

This database has been used to verify the consistency of the service contents beyond the formal checks performed by the validators and helped improve the quality of services. However, fine-tuning is still required to focus the search more accurately in particular cases. The development version is available at <https://voparis-elasticsearch.obspm.fr/dev3> (with minimal user interface)

This interface may become the basis for an alternative query mode in the main portal, as it provides a very fast and easy view of all services in a way that would be difficult using TAP SQL-like queries.

Geospatial portal

An unforeseen application of the ElasticSearch database is to facilitate cross-service searches based on spatial coordinates, mainly in support of planetary surface and atmosphere studies in a GIS-like environment.

The VESPA geospatial portal (<http://voparis-explore.obspm.fr>) has been developed in the frame of an internship at ObsParis. It allows the user to search for any georeferenced data product in a Region of Interest (RoI) on a given Solar System body. Such RoI can be drawn manually, imported or converted from GIS formats (ArcGIS shape files), or extracted from a HiPS within a range of values. This latter functionality enlarges the use of HiPS beyond the usual contextual basemap, and actually turns HiPS into a source of quantitative information – this is particularly relevant for maps of mineralogical or chemical abundance. Spatial queries can of course be coupled with other filters such as ranges in time or frequency.

This application reuses developments of CNRS/CDS for astronomy: AladinLite for display and MOC/HiPS management libraries. It triggered in turn improvements to these libraries as well as HiPS and MOC standards and the DaCHS framework.

This late activity of the JRA indicates fruitful perspectives for further developments in a future project.

Contribution to astropy library

VESPA contributed to the community Python library astropy to support coordinate systems related to planetary surfaces. This is included in Astropy v6.0, released on Nov 27, 2023:

- Fits planetary keywords defined by Marmo et al 2018 (during Europlanet 2020 RI) were implemented in the official WCSlib v8.0 in July 2023. This allows defining custom planetary models as 3-axes ellipsoids, and potential support of IAU coordinate frames in fits files and libraries.

- Support for bodycentric latitudes and longitudes was added to astropy. This allows conversions between various frames (e. g., planetodetic vs planetocentric coordinates, surface coordinates to celestial ones) or spheroidal models, and between spatial and pixel coordinates, e. g., for image cut-outs.

- Jupyter notebooks illustrating these new capacities are available on <https://github.com/epn-vespa/tutorials/tree/master/surfaces/astropy-planetary-coordinate-frames>

Task 4

- (Follow-on of MS25) The Vizier_planets service was published during year 2 in a somewhat preliminary form, due to specificities of Planetary Science data not necessarily implemented in a mainly astronomical archive. The service was updated during years 3 and 4 to extend the period of interest (up to present), remove remaining outliers, and improve the description of planetary data collections from publications.

- Spatial footprints were initially described in VESPA using systems of contours from older IVOA protocols. During year 3, we tested as a possible alternative the use of MOCs, which are lists of healpix cells at varying resolution. This system can handle non-connected regions and proves to be much quicker when searching for intersections or overlaps. It is supported by Aladin and more recently by TOPCAT. MOC are now recommended for new data services and are computed for all services with georeferenced data in the ElasticSearch database at ObsParis.

- Work has been done with ESA and NASA PDS/PPI (UCLA) independently, to optimize access to space agency data. ESA archive has been fine-tuned to facilitate incremental updates. The ~ 180 NASA PPI data collections will be published in the VESPA VA within the end of the programme.

VESPA: infrastructure

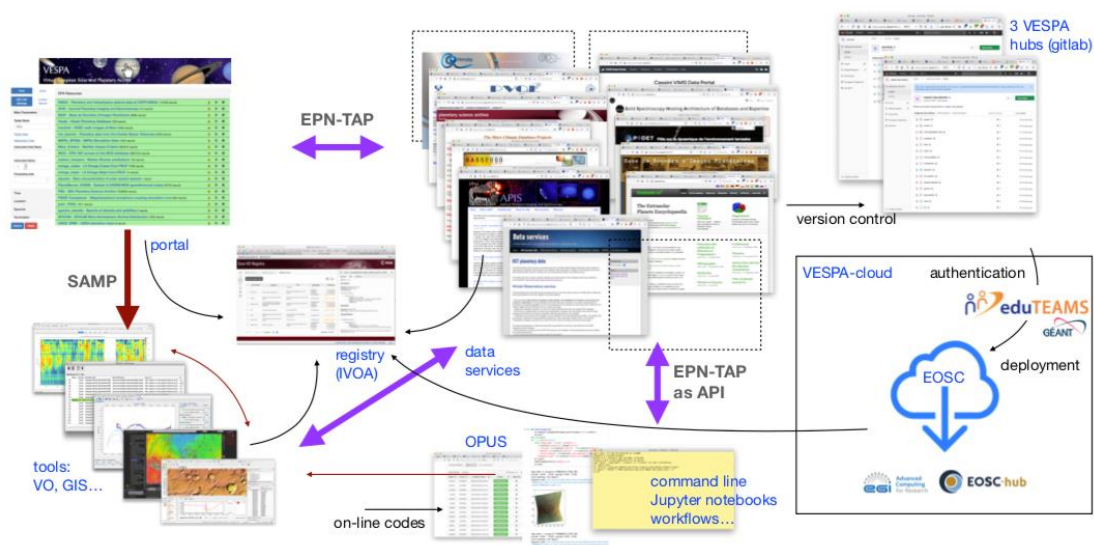


Figure 1: VESPA schematic infrastructure.

c) Impact to date

The VESPA JRA is mostly in support of the VA, which delivers most of the impact to the scientific community. Continuous and focused technical activities have reinforced the weight of contributions of Europlanet 2024 RI/ VESPA to IVOA Interop, to IPDA meetings with space agencies, and to the IHDEA meetings for heliophysics. In the IVOA alone, VESPA has taken a major role in the Solar System and Radio Interest Groups, as well as in the Data Access, Registry, Semantics and Application Working Groups.

The addition of functions in support of Planetary Science in the standard VO tools certainly tightens the links with the Astronomy community and increases the visibility of Planetary Science in the Astronomy VO and the developer community.

Support for EPN-TAP has been implemented by the developers of community libraries such as pyvo and astroquery.

Besides, direct contributions by Europlanet/VESPA and Chiara Marmo during year 4 were very much appreciated by the astropy community — credits are given on <https://www.astropy.org/credits.html>

Most developments listed here have been presented at the ADASS conference in Nov 2023 in Tucson, Az, and/or at the associated IVOA Interop meeting: ImageJ plugin, astropy contribution, upgraded VESPA portal, discovery and geospatial portals.

d) Follow-up activity / sustainability

After the end of the JRA, the related developments will carry on in institutes which benefit from other sources of funding. This is made possible through careful planning and close links formed with broader-scope projects during the programme:

- Further improvements of the VESPA portal, including gallery view and thematic grouping of services.
- “natural language” interface to circumvent the technicity of the TAP / ADQL interface – as a possible alternative query system.
- Geoportal as an alternative user interface to support surface studies, and more interactions with GIS-compliant tools and standards.
- Collection of planetary science user inputs to drive the evolution of VO tools.
- Further implementation of services on EOSC, including radio services and spectral interpretation system relying on bandlist.

In France, 3 national data services derived from Europlanet/VESPA are certified by CNRS/INSU and are eligible to manpower and resources: VESPA-F, MASER (ObsParis) and SSHADE (OSUG). VESPA-F and SSHADE participate to CNES/INSU data nodes for planetary surfaces and small bodies, while MASER is tightly linked to the CDPP (OMP/IRAP). CDS is a national Research Infrastructure supporting VizieR, Aladin and a continuous participation to the IVOA.

VO tools and frameworks are supported by various means and weight heavily in IVOA developments: TOPCAT, Aladin, DaCHS, CASSIS. VO data centres (in Heidelberg, Trieste, Strasbourg, Toulouse, Paris) are supported independently and require regular improvements of their infrastructure.

2. Update of data management plan

Not applicable for JRA2 WP7.

3. Follow-up of recommendations & comments from previous review(s)

- The review panel recommended to move the VESPA portal to https, which has been done during year 3.

- The RP2 report review letter mentions

“A rather significant number of milestones remain not reached, without explanation, notably MS 48, ..., 66, 68, 70.” [MS50 and 60 are not from VESPA]

This has been answered in real time:

- MS48 (previous portal update) had been reached earlier and published in June 2022. That was however an intermediate version replaced by a further update later on. The history is provided in the D7.8 document.
- MS66, 68, 70: see VESPA VA report.
- Other MS have been reached in the meantime.